# IMPACT OF PROTECTED AREAS ON WESTERN COUNTY ECONOMIC OUTCOMES, 1976 – 2014

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**ABSTRACT**

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A limited number of studies have approached the task of measuring the economic worth of conservation. Even fewer studies focus on the impact of protected areas. Additionally, past studies fall short of showing a causal effect of establishing protected areas. Using newly-created panel data showing a county's exposure to protected areas over time, this paper attempts to find a causal relationship between protected areas and employment outcomes on the county level in the United States. Panel data allows for the use of fixed effects models, controlling for heterogeneity across counties and years. Results show ambiguous and sometimes conflicting outcomes on labor force, employment and unemployment, with no significant outcomes on the employment and unemployment rates.

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## INTRODUCTION

How can an economic value be placed on nature, and how can the worth of conservation be measured? Conservation concerns have changed tones over the years. In the nineteenth and early twentieth century, conservation goals focused on setting aside land for resource extraction, ensuring the availability of land and resources for future generations. The preservationist movement, led by John Muir, conflicted with early conservationists – the goal instead being to protect wilderness areas by setting them aside to remain unused. By the 1960s and 70s, the environmental movement was in full swing – people became more aware of damage to certain species of plants or animals, developing concern for habitat preservation came out of the field of ecology, and support for environmental protection culminated in a number of pieces of federal legislation and the establishment of the Environmental Protection Agency in 1970 (Chapman 2019).

A limited number of studies measure the effects of conservation areas or other types of public land on economic outcomes (such as income, population, and employment). Even fewer specifically study the impact of protected or conservation areas. In addition, prior work tends to fall short of establishing a causal relationship between the creation of a conservation area specifically and a corresponding change in local economic outcomes. This study begins to fill this gap in the literature.

Public land is diverse and can serve a variety of purposes, from resource extraction to the protection of species. The type of public land in question can influence the effect it has on local economies. For example, public land set aside for logging could have positive impacts on local employment and wages due to the increase in resource extraction activity. In contrast, land set aside for a national wildlife refuge might also generate activity by providing maintenance jobs, attracting local visitors that consider natural areas an important recreational amenity, or drawing tourists to the town to see a rare bird. Public land designated as off limits to any uses would likely diminish local economic activity. Thus, variation in allowable uses of public land may affect its economic impacts. Of course, local economic impacts may not be the most important social impact of public lands. Goods such as habitat protection, preservation of natural areas, and species health also weigh in to decisions regarding how much land to protect.

This paper attempts to find a causal relationship between public conservation areas and employment outcomes at the county level by looking at a county's exposure to federal conservation land over time through panel data. Hopefully, this will shed some light on the true economic impact of establishing protected areas on local economies.

## LITERATURE REVIEW

In "Conservation Reconsidered", published in September 1967, John Krutilla discusses the shift in conservation as a concern for natural resource availability to concern about the protection of natural areas for research and personal enjoyment (777-778). Krutilla argues that the value of natural and undisturbed land is already higher than assumed due to option demand, or the value a person places on having the option to go to a natural area or to simply know it exists (780). Additionally, he predicts the value of public land will increase in the future because the value of outdoor recreation increases with income and because as depletion of natural areas increases, the value of those remaining will increase (782-784).

A similar paper, written by Robert Nelson in 2006, focuses on understanding the failures of economic analysis in placing monetary values on nature (as Krutilla suggested we do nearly 40 years earlier). During his time with the Bureau of Land Management (BLM), Nelson encountered the difficulties of actually completing a benefit-cost analysis of public land firsthand when trying to calculate the economic benefits of the BLM's livestock grazing program. Nelson also addresses the high costs of even doing this type of analysis – finding measures for every piece of public land is nearly impossible, and could cost more than the actual benefit of the land itself. Although difficult, an economic analysis of the benefits of public land, especially protected areas, is essential to confronting the continually relevant question of when to preserve nature and when to exploit it. Krutilla and Nelson's papers provide a foundational understanding of the issue that the empirical models below attempt to solve in part: the need for economic analyses of the costs and benefits of protecting nature.

In 1997, a study of 250 non-metropolitan western counties in the United States showed that state parks have a positive effect on county economies, consistent with a hypothesis that households gravitate towards these "high amenity regions" (Duffy-Deno 1997, 201). Specifically, the study found that counties with a greater density of state parks also experienced a greater employment and population density, all else constant, leading to the conclusion that the existence of state parks may positively and directly affect county-level economic development (217-218).

Although this study bodes well for the hope that conserving land has positive environmental and economic effects, it looks at exposure at one point in time, not over time. Because of this, stating that the creation of these state parks *caused* improved county outcomes proves difficult. Researchers need a comparison of these effects over time within counties to control for underlying county characteristics that confound the ability of a cross-sectional analysis (like Duffy-Deno's) to estimate causal relationships. Duffy-Deno uses comprehensive equations and variables to control for certain confounding factors, but ultimately looks at the number of parks in one year, and the population and employment data for one year only. This study lacks information about how the number of parks has changed over time in relation to the population and employment density outcomes discussed.

In 2003, Paul Lorah and Rob Southwick analyzed "the relationship between protected federal lands (wilderness, national parks, national monuments and roadless areas) and nearby communities in the rural western United States" (255). This study is closely related to the question of this paper in that it examines the impact of federal protected lands on county level outcomes, but examines population, employment, and income growth from 1969-1999 using a measure of federal land exposure at a single point in time, not considering changes in the spatial distribution of federal land over time. Lorah and Southwick again show reason to support environmental protection, finding that jobs and the environment need not compete: nonmetro counties with protected federal lands within 50 miles of their center grew faster than those without, and those with the most protected land grew even more – in terms of employment, population, and total income (262-66).

The estimates found, however, lack causality – "the presence of protected federal lands is **correlated** with relatively high rates of population, income, and employment growth in the rural west [emphasis added]" (Lorah and Southwick 2003, 256). This correlation, while exciting in that it establishes potential economic benefits to environmental conservation – even for rural areas thought to depend highly on extraction activity – does not imply causation. Still, clearly environmentalism and economic growth need not oppose each other. The environment can attract economic activity of its own as counties become centered in the service sector rather than resource extraction (268-69).

Headwaters Economics released a study in 2017 that found rural western counties performed better in regards to percent change in population, employment, personal income, and per capita income from 1970 to 2015 when they had more federal land (Lawson 2017). The effect was similar when looking at all federal lands or only protected federal lands, although performance seemed slightly higher for those with a higher share of protected federal lands. This analysis does not empirically estimate the effect of federal land or offer any plausible explanation of causation. Lawson (2017) summarizes statistics showing the relationship between the percent of federal land as calculated in 2016 and certain changing economic and demographic statistics in rural western counties. Perhaps certain types of land or certain regions were pre-disposed to selection for federal land ownership. For example, if counties showing promising growth were selected for new plots of federal land during the study period, this could explain their observed performance.

Not all studies find a positive impact or correlation of land protection with economic outcomes. In 2008, a study on federally-owned wilderness land evaluated the effects of this specific type of land designation in the rural eastern United States, and concluded that the shift away from resource extraction and manufacturing towards services and nonlabor income was not impacted by wilderness. Wilderness designation slightly delayed transitions in counties that had any wilderness, but counties with a higher density of wilderness transitioned sooner. The effect, however, was too small to be conclusive (Rosenberger *et. al.* 2008, 276-79).

The eastern United States has a smaller amount of wilderness or protected land than the western United States (Rosenberger *et. al.* 2008, 279). This study does not seek to determine the causal impacts of establishing new protected areas on county economic outcomes. Rather, Rosenberger *et. al.* examined the impact of protected or wilderness areas on the transition of a county's economic activity. Perhaps counties with higher amounts of wilderness did not depend highly on resource extraction in the first place, as a piece of land's protection status is not an indicator of whether or not it contains valuable raw resources (279).

A 2010 study using the Northwest Forest Plan as a natural experiment showed a significant negative effect on local employment growth and net migration after federal timberland was re-designated as conservation land (Eichman *et. al.* 2010, 331). One of the limitations of this study is that it looks at already productive public land (timberland) and county outcomes after this land was re-designated as conservation land, rather than examining land that previously had no designation and became conservation land. Additionally, the studied conservation land was designated for the protection of northern spotted owls, not necessarily for recreation, tourism, or other potential job-creating activities. These limitations do not allow the study to demonstrate a causal impact of protected areas on county level outcomes.

Outside of the United States, Sims (2010) produced causal estimates of the impact of protected areas on local economic outcomes. In Thailand, ordinary least squares and instrumental variable analysis suggested that localities with higher exposure to protected areas had lower poverty rates and higher consumption – perhaps as a result of drawing in tourism (Sims 2010, 95). Although the effect of protected areas in Thailand likely differ from those in the United States due to the drastic differences between the two countries, finding a causal estimate of protecting land on a local economy can help guide future research and analysis.

## STUDY AREA AND DATA

At the beginning of this study, no panel data were available on county exposure to protected areas and economic outcomes in the United States. By using geographic information systems (GIS) to generate measurements for county exposure to protected areas, I created a panel with county exposure every year from 1976 to 2014, for every county in the western United States. Creating a panel allowed me to generate causal estimates of the impact of protected areas by enabling the regression of county employment outcomes on county exposure to protected areas, including fixed effects for counties and years. This will allow for estimation of the impact that an increase in protected areas one year to the next has on county employment outcomes, controlling for variation within and between counties. Past studies, as noted in the literature review, did not use this type of data set or regression model.

While data are available for all public land in the United States, as well as all counties in the United States, it became necessary to limit the study area due to processing constraints. A study of all types of publicly managed land across the United States would provide insight and valuable information about the efficacy of different types of land in improving (or harming) local outcomes, but unfortunately extends beyond the scope of this project. The study area is limited to the western United States (including Washington, Oregon, California, Idaho, Nevada, Montana, Wyoming, Utah, Arizona, Colorado, and New Mexico) as designated by the U.S. Census Bureau. Alaska and Hawaii were excluded from this study, which focuses on the contiguous United States. The western states were chosen for the study area because they have a higher percentage of conserved area compared to other regions of the United States; with the need to limit the size of the dataset for computational purposes in the GIS, I focused on the part of the United States with the most protected land (Figure 1) and the most variation in protected land over time (Figure 2).

Data on county borders from 2013, also in the GIS format, comes from the U.S. Department of Commerce, Economics, and Statistics Administration. Although county borders may change over time, they are assumed to have changed only slightly throughout the span of this study.

*County Economic Outcomes Data*

For the dependent variables, this analysis uses data on annual county level labor force statistics (unemployment rate, labor force size, number of unemployed and number of employed persons) from the Bureau of Labor Statistics. The measures from 1976-1989 are unofficial, but appropriate for the scope of this analysis. Data from 1990-2017 also come from the BLS, and are official. The employment rate was generated using basic mathematical functions. Summary statistics are reported in Table 1. Each county in the data set is uniquely identified by its 5-digit Federal Information Processing Standards

(FIPS) code, as well as a year. This allowed me to match observations from my geographical data set onto those of the county economic outcome data.

*Protected Areas Data*

Data on protected areas in the United States come from the U.S. Geological Survey's Protected Areas Database – United States (PAD-US), which contains Geographic Information System (GIS) layers of all of the United States' protected areas as recent as 2014. I limit public land to federally-managed areas designated by the International Union for the Conservation of Nature's (IUCN) protected areas, levels I through V. This encompasses as many pieces of preserved land as possible, ranging from strict nature preserves (category Ia) to protected landscapes and seascapes (category V). I eliminated category VI, protected areas with sustainable use of natural resources, from this analysis because this study focuses primarily on the impacts of wilderness/non-extraction land.

In order to generate measures of a county's exposure to public lands over time, I used an open-source GIS software called QGIS. I generated maps for each year in the study area including the boundaries of the protected areas as well as county boundaries, and used these to calculate the total area of each protected area that fell within each county. Figure 2 shows a map of the IUCN-designated preserved areas used to create the independent variables in this study in 1976, the first year of the study, side by side with a map of 2014, the last year. This demonstrates the growth and spatial variation in protected areas in the western United States over time. I summed these measures and divided them by the corresponding county's area in order to generate a percentage of land composed of protected areas by county-year. Additionally, I generated a binary variable that indicated whether or not each county had any protected areas at all in each year. Table 1 reports summary statistics of these measures. Measuring county exposure in this way may not account for all possible effects of protected areas on a given county, as nearby land just outside the county border could also influence economic outcomes. However, measuring exposure in this way provides a general method to account for variation of protected areas within counties, across time.

## METHODS AND MODELS

*Models Without Fixed Effects*

The first set of models include basic pooled regression models, a similar approach to some existing literature, as follows:

$$econactivity_{it} = \beta_1 protected_{it} + \epsilon_{it} \tag{1}$$

$$econactivity_{it} = \beta_1 protected_{it} + \beta_2 presence_{it} + \epsilon_{it} \tag{2}$$

where $econactivity_{it}$ is a general term for all economic outcome variables used separately in this study (labor force, number of employed, number unemployed, employment rate, or unemployment rate). $protected_{it}$ is the percent area of county *i* in year *t* composed of protected areas, and $presence_{it}$ is a binary variable stating whether or not a county had any protected areas within its borders in a given year. $\epsilon_{it}$ is the standard econometric error term. In equation (1), $\beta_1$ represents the marginal effect of a one percent increase in the area of protected land in a county on the economic outcome measure. In equation (2), $\beta_1$ represents the marginal effect on the economic outcome measure of a one percent increase in the area of protected land in a county, conditional on having any protected land present at all. $\beta_2$ estimates the impact of having any protected land present on the economic outcome measure.

*Models Including Fixed Effects*

The pooled models in equations 1 and 2 are subject to omitted variable bias, since observable and unobservable county characteristics may determine both economic outcomes and federal land presence and extent. In order to reduce the possibility of omitted variable bias, this model includes fixed effects. Fixed effects control for differences between counties and differences between years in this model. Including these, with the county economic variable as the dependent variable and the measure of county exposure to protected areas, I estimate equation 3:

$$econactivity_{it} = \beta_1 protected_{it} + \alpha_i + \gamma_t + \epsilon_{it} \tag{3}$$

The county fixed effect, $\alpha_i$, controls for non-time-varying observable and unobservable county characteristics correlated with economic outcomes, and the year fixed effect, $\gamma_t$, controls for time-varying factors (such as macroeconomic factors) common to all counties. $\epsilon_{it}$ is the standard econometric error term. The dependent and explanatory variables are defined in the same way as equations (1) and (2). The coefficient of interest is $\beta_1$, which will estimate the impact of a one percent increase in a county's protected land area on the economic outcome measure.

The binary variable was also included in fixed effects models as in equation 4:

$$econactivity_{it} = \beta_1 protected_{it} + \beta_2 presence_{it} + \alpha_i + \gamma_t + \epsilon_{it} \tag{4}$$

All other variables are defined in the same way as equation (3), however, $\beta_1$ now estimates the marginal effect of a one percent increase in the protected land area in the county on the economic outcome measure, conditional on the presence of any protected land.

*Extensions*

Additional models including state-year fixed effects control for possible macroeconomic differences between states, in addition to differences between counties. These models include an economic outcome as the dependent variable and protected area percentage and presence as explanatory variables (one with the presence indicator, one without). They are as follows:

$$econactivity_{it} = \beta_1 protected_{it} + \alpha_i + \sigma_{st} + \epsilon_{it} \tag{5}$$

$$econactivity_{it} = \beta_1 protected_{it} + \beta_2 presence_{it} + \alpha_i + \sigma_{st} + \epsilon_{it} \tag{6}$$

A second extension of the basic pooled and fixed effects models is a model capturing discrete ranges of protected area coverage in a county-year using bins. This type of model allows for an understanding of how different categories of exposure to protected areas (minimal to intense) impacts economic outcomes. Counties were categorized as having percent protected area in one of four quartiles. Table 2 reflects the distribution of observations across quartiles. The model for using bins is equation 7:

$$econactivity_{it} = \beta_1 presence_{it} + \beta_2 quart2 + \beta_3 quart3 + \beta_4 quart4 + \alpha_i + \gamma_t + \epsilon_{it} \quad (7)$$

In equation 7, $quart2$, $quart3$, and $quart4$ are all binary variables equal to 1 for any county-year in which the fraction of protected area in a county falls into quartiles two through four, respectively. $\beta_1$ estimates the effect of having any protected area, while $\beta_2$, $\beta_3$, and $\beta_4$ all estimate the effects of the size of protected area relative to having protected area in the smallest quartile, conditional on the presence of some protected area. $\alpha_i$ and $\gamma_t$ are county and year fixed effects, as previously defined, and $\epsilon_{it}$ is the standard econometric error term.

## RESULTS

Results from the basic pooled models and fixed effects models (equations (1) through (4)) using labor force as the dependent variable are reported in Table 3. The pooled models in columns 1 and 2 both yield highly significant and positive results for the impact of protected area on labor force, however, they do not control comprehensively for differences between counties and years.

The fixed effects models in columns 3 and 4 also yield positive coefficients for protected areas on labor force, but these are not significant. Column 4, which includes both percentage of protected area and the binary area indicator in the explanatory variables, yields a significant ($p < 0.05$) and negative estimate for the effect of having any protected area in the county.

Results from using employment as the dependent variable are reported in Table 4. The pooled models yield highly significant and positive results, but do not control for differences between counties and years. The fixed effects models also yield positive coefficients for protected areas on employment similar in magnitude but not significant. Column 4 shows a significant ($p < 0.05$) negative estimate for the effect of having any protected area in the county.

Results using unemployment as the dependent variable are reported in Table 5. Coefficient estimates for percent of county protected area from the pooled models are positive and significant, but do not control for county and year differences. The fixed effects models both also yielded positive and weakly significant results ($p < 0.10$) for the effect of percent protected area. In column 4, having any protected area at all was estimated to have a significant ($p < 0.05$) and negative effect on the number of unemployed persons.

Results using the unemployment rate as the dependent variable are reported in Table 6. Counter to the earlier results, the pooled models in Table 6 actually suggest that protected areas increase the unemployment rate (though the presence of any protected area is negative, suggesting a decrease in the unemployment rate). However, none of the results in the panel fixed effects models differ significantly from zero. Results using employment rate as the dependent variable had estimates opposite in sign with nearly equal magnitudes to those from the unemployment rate, and are therefore not reported here, but are available upon request.

Coefficient estimates using state-year fixed effects are reported in Table 7. Models using labor force, employment, and unemployment as the dependent variable all had negative and significant estimates for the effect of having any protected area at all within a county ($p < 0.05$), but no other estimates were statistically significant. Using employment rate and unemployment rate as dependent variables did not yield any statistically significant results; these results are not reported here, but are available on request.

Table 8 contains results from the discrete ranges model. Using labor force, employment, and unemployment as dependent variables yielded significant and negative estimates for the effect of being in the third quartile. This means that, relative to counties with percent protected area in quartiles 1, 2, and 4, those with a percent protected area in quartile 3 experience negative impacts on labor force, employment, and (weakly) unemployment. (There is not enough within-county variation in the largest protected areas over time to identify an impact of being in the top quartile in these models).

## DISCUSSION AND CONCLUSIONS

In almost all of the models estimated in this paper, the pooled models suggest a positive and significant effect of protected areas on county economic outcomes. In contrast, the panel fixed effects models typically suggest either no effect, or a negative effect of protected areas on economic outcomes. This emphasizes the importance of controlling comprehensively for observable and unobservable county characteristics when assessing the impact of conservation on local economies. To my knowledge, none of the papers in the literature currently estimate plausibly causal impacts.

In several of the panel fixed effects models, the impact of having any protected area at all has a significant and negative impact on economic outcomes, and the conditional effect of protected area size is positive (though not significant). Taken together, these results suggest that, conditional on having any protected land at all, having more may prove advantageous. This type of outcome appears in the county and year fixed effects model as well as the state-year fixed effects model. Perhaps counties with smaller tracts of land that do not attract tourism or many jobs do not benefit from the establishment of a protected area, as it potentially takes away from other economic opportunities such as resource extraction. However, counties with larger pieces of land (such as a national park or forest) may experience an influx of tourism, generating activity both around the protected area and in stores, hotels, and restaurants nearby. Capturing the impacts of some of these larger protected areas proves difficult, as they were established long ago (for example, Yellowstone National Park in Wyoming was established in 1872), and no data are readily available on the employment and labor statistics for those time periods.

However, the results from the discrete ranges (bins) model contradict this potential explanation. In the discrete ranges model, the presence indicator is positive (although not significant, perhaps due to high standard error). Relative to being in the smallest quartile, being in the third quartile has a relatively large and statistically significant negative effect on the labor force size. These opposing results could perhaps mean my models fail to capture an important factor. Perhaps the type of protected area (national parks, wildlife preserves, or national forests, for example) influences the impact a protected area has on economic outcomes. Different types of areas likely differ in size.

Clearly, however, different sizes of protected areas lead to differing outcomes on county labor force size. Also problematic is the failure of the bins model to yield estimates for being in the fourth quartile. As noted above, a lack of enough variation in these largest protected areas over time makes it difficult to determine the effects of the largest protected areas on county economic outcomes.

The effect of having any protected area at all on the number of employed persons was negative and significant in its effect, as well as the effect on the number of unemployed. In fact, adding these two estimates together does yield an estimate nearly equal the effect on labor force. Perhaps having protected area within a county drives people to leave the labor force altogether. Counties with higher percentages of protected area may have different demographic compositions over time – perhaps counties with more protected area attract more retirees, thus leading to a drop in the labor force size.

Employment may also respond in specific ways to protected areas. This especially applies to protected areas established on tracts of land used for extraction activities prior to their designation as protected areas. The results from the county and year fixed effects model with employment as the dependent variable, while negative for having any protected area at all, also had a positive but not significant estimate of the effect of a one percent increase in county protected area (Table 4). The state-year fixed effects model (Table 9) yielded a similar pattern of results, although the magnitudes of these effects differed. Like with labor force, the discrete ranges model estimates a large negative effect of being in the third quartile. These negative effects are present but much smaller in the second quartile. Again, the positive effect of percent county protected area predicted by the county and year fixed effects model and state-year fixed effects model is contradicted by the large and significant negative effect of being a county in the upper distribution of percent protected area.

The effects of having any protected area at all on unemployment are negative and significant, which means having protected area decreases the number of unemployed people. This effect appears in the county and year fixed effects model and the state-year fixed effects model. Having more protected area, according to fixed effects models, leads to an increasing level of unemployment. However, the discrete ranges model again contradicts this by yielding larger estimates of decreases in unemployment for being in a higher quartile (omitting quartile 4 and its 0 estimated effect).

It appears that protected areas, while decreasing the size of the labor force and the number of employed people, also decrease the number of unemployed people. While perhaps protected areas remove certain opportunities for employment or labor size growth, they may offer jobs appealing to those trapped in a bout of unemployment by creating new opportunities for work. Unemployed people remain part of the labor force, and therefore their movement into the employed category of the labor force will not change that number. However, the effect on unemployment is not significant enough to counteract the larger negative effect on employment.

County and year fixed effects models, state-year fixed effects models, and the discrete ranges model all failed to yield any statistically significant results for the employment rate and the unemployment rate. The estimates are roughly equal and opposite in effect, suggesting that for any decrease in the employment rate, unemployment rate responds with a corresponding increase. The estimates are all small, with any change in the employment or unemployment rate being fractions below 1%.

## AREAS FOR FURTHER RESEARCH

Moving forward, analyzing these data with consideration for the type of protected area may provide insight that my models failed to capture. Including state and local protected areas would increase the observed within-county variation in protected area borders over time. Additionally, using another method to measure exposure to protected areas might harness a keener understanding of the impact protected areas have on county outcomes. My measure only included land within county borders, but land right outside of a county border may impact the county as well. Other kinds of economic data at the county level may provide useful analysis, such as data available from the Bureau of Economic Analysis on personal income and, as it becomes available, data on county-level GDP. Along this line, finding some measurement of economic activity available for earlier time periods in order to capture the effects of older and larger protected areas would extend the possible time period of study. Lastly, expanding the study area to the eastern United States could provide more understanding and an interesting comparison between the ways protected areas impact different regions of the United States.

Creating a panel for exposure to protected areas over time opens up a plethora of new possibilities for analysis on protected areas and other types of public land. Understanding the effects of setting aside land for some purpose other than development is essential to decisions about the conservation and protection of nature. The results from this paper span only a small amount of potential analysis in the area of the economics of public lands.

# References

Bureau of Labor Statistics. *Archived county employment data (UNOFFICIAL)*. 1976-1989. Distributed by request via email from Brian Hannon, BLS.

Bureau of Labor Statistics. *Local Area Unemployment Statistics: Labor force data by county, annual averages.* 1990-2017. Distributed by the Bureau of Labor Statistics. https://www.bls.gov/lau/tables.htm.

Chapman, Ann E. "American Conservation in the 20th Century." National Park Service. Accessed February 4, 2019. https://www.nps.gov/nr/travel/massachusetts_conservation/American_Conservation_in_the_Twentieth_Century.html.

Duffy-Deno, Kevin T. "The Effect of State Parks on the County Economies of the West." *Journal of Leisure Research* 39, no. 2 (1997): 201-221.

Eichman, Henry, Gary L. Hunt, Joe Kerkvliet and Andrew J. Plantinga. "Local Employment Growth, Migration, and Public Land Policy: Evidence from the Northwest Forest Plan." *Journal of Agricultural and Resource Economies* 35, no. 2 (August 2010): 316-33. https://www.jstor.org/stable/41960520.

Krutilla, John C. "Conservation Reconsidered." *American Economic Review* 57, no. 4 (September 1967): 777-86. http://www.jstor.org/stable/1815368.

Lawson, Megan. "Federal Lands in the West: Liability or Asset?" last modified February 2017. https://headwaterseconomics.org/public-lands/federal-lands-performance/.

Lorah, Paul and Rob Southwick. "Environmental Protection, Population Change, and Economic Development in the Rural Western United States." *Population and the Environment* 24, no. 3 (January 2003): 255-72.

Nelson, Robert H. "Valuing Nature: Economic Analysis and Public Land Management, 1975-2000." *American Journal of Economics and Sociology* 65, no. 3 (July 2006): 525-57. http://onlinelibrary.wiley.com.ezproxy.lib.utexas.edu/journal/10.1111/%28ISSN%291536-7150/issues.

"Protected Area Categories." International Union for Conservation of Nature. https://www.iucn.org/theme/protected-areas/about/protected-area-categories.

Rosenberger, Randall S., Mark Sperow, and Donald B. K. English. "Economies in Transition and Public Land-Use Policy: Discrete Duration Models of Eastern Wilderness Designation." *Land Economics* 84, no. 2 (May 2008): 267-81. http://le.uwpress.org.ezproxy.lib.utexas.edu/content/by/year.

Sims, Katharine R. E. "Conservation and development: Evidence from Thai protected areas." *Journal of Environmental Economics and Management* 60 (2010): 94-114.

U.S. Department of Commerce, Economics, and Statistics Administration. *Census Regions and Divisions of the United States* [map]. 2013. 1:400. "U.S. Census Bureau." https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf.

U.S. Geological Survey, Gap Analysis Program (GAP). *Protected Areas Database of the United States (PAD-US).* V 1.4 Combined Feature Class. May 2016. Distributed by U.S. Geological Survey. https://gapanalysis.usgs.gov/padus/data/download/.

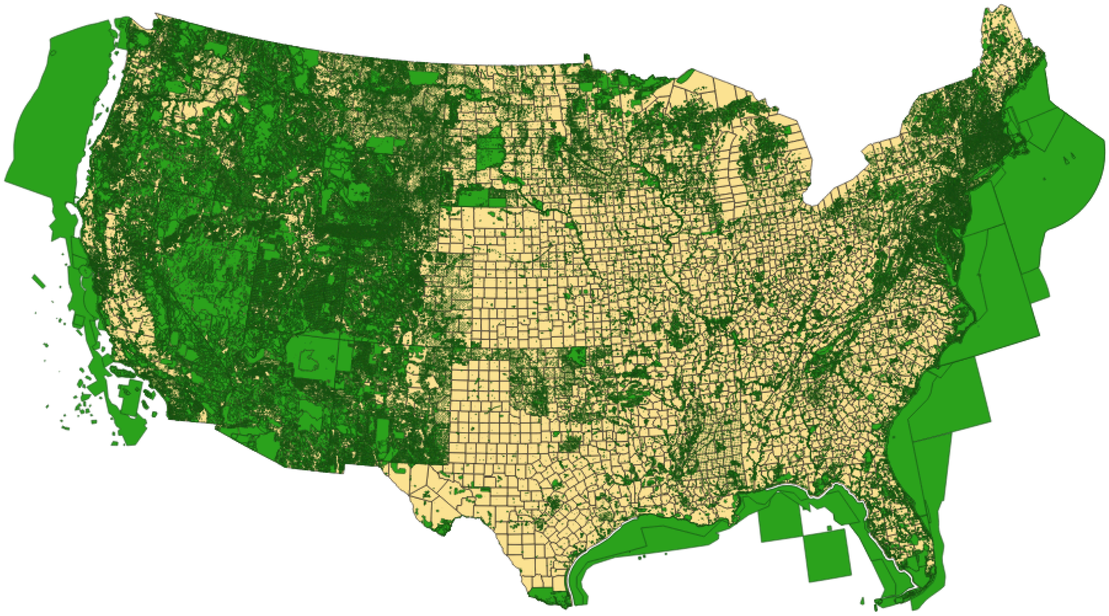

Figure 1: Map of protected areas in the contiguous United States. Protected land is shaded in green.

1976

2014

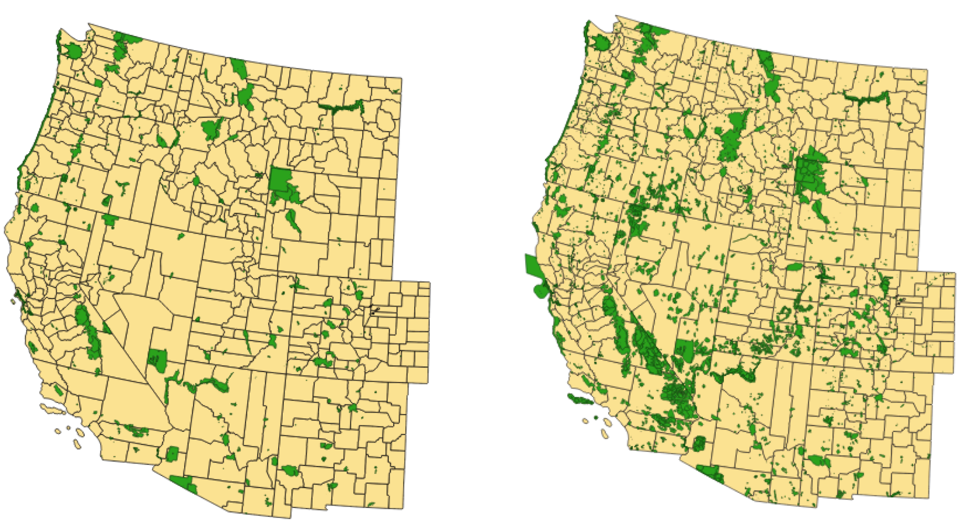

Figure 2: Map of federally managed protected areas in the western United States, 1976 (left) and 2014 (right). Protected land is shaded in green.

Table 1: Descriptive statistics

| Variable | N | Mean | Std. deviation | Min | Max |
|---|---|---|---|---|---|
| *County economic outcomes* | | | | | |
| Labor Force | 16,120 | 67180.11 | 266640.4 | 123 | 5004087 |
| Number Employed | 16,120 | 62494.87 | 247791 | 120 | 4614776 |
| Number Unemployed | 16,120 | 4685.671 | 20104.21 | 2 | 615101 |
| Employment Rate (%) | 16,120 | 92.63009 | 3.762642 | 60.8403 | 99.39394 |
| Unemployment Rate (%) | 16,120 | 7.369919 | 3.762621 | .6 | 39.2 |
| | | | | | |
| *Protected Areas* | | | | | |
| County Protected Area (%) | 16,120 | 1.139848 | 5.32928 | 0 | 80.86702 |
| Area Presence (binary var.) | 16,120 | .6525434 | .476177 | 0 | 1 |

Table 2: Summary of quantile variables

| Quantile | Freq. | Percent | Cum. |
|---|---|---|---|
| 1 | 5,601 | 34.75 | 34.75 |
| 2 | 2,465 | 15.29 | 50.04 |
| 3 | 4,056 | 25.16 | 75.20 |
| 4 | 3,998 | 24.80 | 100.00 |
| **Total** | **16,120** | **100.00** | |

Table 3: Coefficient estimates for models using labor force as the economic outcome variable

| | Labor force | Labor force | Labor force | Labor force |
|---|---|---|---|---|
| Protected Area (%) | 1158.2** | 1069.5** | 1559.0 | 1618.3 |
| | (394.0) | (398.9) | (1085.7) | (1096.9) |
| Presence (binary) | | 6367.2 | | -9852.8* |
| | | (4464.0) | | (4326.0) |
| constant | 65859.9** | 61806.2** | 40648.0** | 46260.6** |
| | (2147.1) | (3561.9) | (4344.2) | (3323.1) |
| | | | | |
| county FE | No | No | Yes | Yes |
| year FE | No | No | Yes | Yes |
| | | | | |
| observations (N) | 16,120 | 16,120 | 16,120 | 16,120 |
| $R^2$ | 0.001 | 0.001 | 0.086 | 0.088 |

Standard errors in parentheses.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$
Notes: Columns 1 and 2 are pooled models, while columns 3 and 4 include county and year fixed effects models. These models all use labor force size as the explanatory variable, which has a mean of 67,180.11. Additional summary statistics describing the labor force, protected area, and presence indicator can be found in Table 1.

Table 4: Coefficient estimates for models using employment as the economic outcome variable

| | Employment | Employment | Employment | Employment |
|---|---|---|---|---|
| Protected Area (%) | 1044.3** | 956.1** | 1399.9 | 1455.3 |
| | (366.1) | (370.7) | (996.8) | (1007.2) |
| Presence (binary) | | 6328.1 | | -9195.4* |
| | | (4148.5) | | (4047.4) |
| constant | 61304.5** | 57275.7** | 37147.7** | 42385.8** |
| | (1995.4) | (310.1) | (4198.7) | (3247.6) |
| | | | | |
| county FE | No | No | Yes | Yes |
| year FE | No | No | Yes | Yes |
| | | | | |
| observations (N) | 16,120 | 16,120 | 16,120 | 16,120 |
| $R^2$ | 0.001 | 0.001 | 0.086 | 0.088 |

Standard errors in parentheses.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$
Notes: Columns 1 and 2 are pooled models, while columns 3 and 4 include county and year fixed effects models. These models all use the number of employed persons as the explanatory variable, which has a mean of 62,494.87. Additional summary statistics describing the employment, protected area, and presence indicator can be found in Table 1.

Table 5: Coefficient estimates for models using unemployment as the economic outcome variable

| | Unemploy. | Unemploy. | Unemploy. | Unemploy. |
|---|---|---|---|---|
| Protected Area (%) | 113.9** | 113.4** | 159.1+ | 163.0+ |
| | (29.70) | (30.07) | (94.69) | (95.51) |
| Presence (binary) | | 37.82 | | -656.6* |
| | | (336.5) | | (316.8) |
| constant | 4555.8** | 4531.8** | 3502.7** | 3876.8** |
| | (161.9) | (268.5) | (196.0) | (159.2) |
| | | | | |
| county FE | No | No | Yes | Yes |
| year FE | No | No | Yes | Yes |
| | | | | |
| observations (N) | 16,120 | 16,120 | 16,120 | 16,120 |
| $R^2$ | 0.001 | 0.001 | 0.053 | 0.054 |

Standard errors in parentheses.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$
Notes: Columns 1 and 2 are pooled models, while columns 3 and 4 include county and year fixed effects models. These models all use the number of unemployed persons as the explanatory variable, which has a mean of 4,685.671. Additional summary statistics describing the unemployment, protected area, and presence indicator can be found in Table 1.

Table 6: Coefficient estimates for models using unemployment rate as the economic outcome variable.

| | Unemp. rate | Unemp. rate | Unemp. rate | Unemp. rate |
|---|---|---|---|---|
| Protected Area (%) | 0.0243** | 0.0262** | 0.0152 | 0.0158 |
| | (0.00556) | (0.00563) | (0.0330) | (0.0333) |
| Presence (binary) | | -0.136* | | -0.0979 |
| | | (0.0630) | | (0.291) |
| constant | 7.342** | 7.429** | 7.633** | 7.689** |
| | (0.0303) | (0.0502) | (0.126) | (0.216) |
| | | | | |
| county FE | No | No | Yes | Yes |
| year FE | No | No | Yes | Yes |
| | | | | |
| observations (N) | 16,120 | 16,120 | 16,120 | 16,120 |
| $R^2$ | 0.001 | 0.001 | 0.389 | 0.389 |

Standard errors in parentheses.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$
Notes: Columns 1 and 2 are pooled models, while columns 3 and 4 include county and year fixed effects. These models all use the unemployment rate expressed as a percentage as the explanatory variable, which has a mean of 7.369919. Additional summary statistics describing the unemployment rate, protected area, and presence indicator can be found in Table 1.

Table 7: Coefficient estimates for state-year interaction models

| | Labor force | Labor force | Employment | Employment | Unemployment | Unemployment |
|---|---|---|---|---|---|---|
| Protected Area (%) | 395.8 | 469.4 | 296.4 | 365.0 | 99.51 | 104.5 |
| | (1096.7) | (1103.3) | (1010.5) | (1016.6) | (95.35) | (95.87) |
| Presence (binary) | | -12502.5* | | -11646.8* | | -855.0* |
| | | (5036.0) | | (4692.7) | | (386.1) |
| constant | 40968.6** | 48090.6** | 37449.2** | 44083.7** | 3521.8** | 4008.8** |
| | (4056.0) | (3239.1) | (3928.5) | (3154.7) | (182.1) | (181.5) |
| | | | | | | |
| county FE | Yes | Yes | Yes | Yes | Yes | Yes |
| state-year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| | | | | | | |
| observations (N) | 16,120 | 16,120 | 16,120 | 16,120 | 16,120 | 16,120 |
| $R^2$ | 0.189 | 0.191 | 0.188 | 0.190 | 0.159 | 0.160 |

Standard errors in parentheses.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$
Notes: All models include county fixed effects and state-year interactions. These models both labor force size, number of employed, and number of unemployed as the explanatory variables. Summary statistics describing the labor force, employment, unemployment, protected area, and presence indicator can be found in Table 1.

Table 8: Coefficient estimates for discrete ranges model (equation 7) with various economic outcome variables

| | Labor Force | Number Employed | Number Unemployed | Emp. Rate | Unemp. Rate |
|---|---|---|---|---|---|
| Presence (binary) | 8411.2 | 7719.4 | 693.2 | 0.208 | -0.205 |
| | (8658.0) | (8045.8) | (663.8) | (0.302) | (0.303) |
| Quartile 2 | -2269.1 | -1937.6 | -333.0 | -0.0776 | 0.0767 |
| | (8051.3) | (7483.2) | (786.3) | (0.698) | (0.699) |
| Quartile 3 | -30872.0* | -28685.0* | -2187.8+ | -0.210 | 0.209 |
| | (14377.1) | (13317.0) | (1113.9) | (0.249) | (0.249) |
| Quartile 4 | 0 | 0 | 0 | 0 | 0 |
| | (N/A) | (N/A) | (N/A) | (N/A) | (N/A) |
| constant | 44991.3** | 41190.9** | 3802.5** | 92.31** | 7.686** |
| | (3747.9) | (3644.4) | (174.4) | (0.245) | (0.246) |
| | | | | | |
| county FE | Yes | Yes | Yes | Yes | Yes |
| year FE | Yes | Yes | Yes | Yes | Yes |
| | | | | | |
| observations (N) | 16,120 | 16,120 | 16,120 | 16,120 | 16,120 |
| $R^2$ | 0.095 | 0.095 | 0.054 | 0.389 | 0.389 |

Standard errors in parentheses.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$
Notes: Equation 7 includes county and year fixed effects. Summary statistics describing the outcome variables and presence indicator can be found in Table 1, while summary statistics describing the quantile variables can be found in Table 2.

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